Majoranas in all dimensions: From billiards to vortex lines

Prof. Dr. Inanç Adagideli - Sabanci University, Faculty of Engineering and Natural Sciences (FENS), Theoretical Condensed Matter group, Istanbul, Turkey

After weathering a few setbacks, Majorana zero modes continue to intrigue the physics community.

In this talk I will first focus on a physical setting not commonly associated with Majorana physics, but well known from the field of quantum chaos: Majorana billiards i.e. arbitrarily shaped islands of topological superconductors. I will discuss how the classical dynamics influence the localization behavior of Majorana wavefunctions in Majorana billiards. By using a connection between Majorana wavefunctions and eigenfunctions of a normal state Hamiltonian, I will show that Majorana wavefunctions in both p-wave and s-wave topological superconductors inherit the properties of the underlying normal state eigenfunctions. In particular, I will demonstrate that Majorana wavefunctions in topological superconductors with chaotic shapes feature quantum scarring. I will discuss how these results allows the manipulation of a localized Majorana wavefunction by altering the underlying classical dynamics, even when manipulating a local potential away from the region in which the Majorana zero mode is localized.

In the second part of the talk, I will focus on charges bound to vortices in topological materials and discuss how these fractional charges evolve into Majorana zero modes that are also bound to the same vortices, when the materials are brought in proximity with a superconductor. In particular I will focus on proximitized (i) Quantum Anomalous Hall insulators (ii) 3D Topological insulators, (iii) 3D magnetic topological insulators, and present our recent results on how to isolate and manipulate e/4 charges, and how fractional charge/Majorana (abelian/nonabelian anyon) physics differs in different dimensions and physical platforms.